

HUMAN SPACEFLIGHT SAFETY FOR THE NEXT GENERATION OF ORBITAL SPACE SYSTEMS

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The National Aeronautics and Space Administration (NASA) Commercial Crew Program (CCP) has been chartered to facilitate the development of a United States (U.S.) commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from low Earth orbit (LEO) and the International Space Station (ISS) as soon as possible. Once the capability is matured and is available to the Government and other customers, NASA expects to purchase commercial services to meet its ISS crew rotation and emergency return objectives.

The primary role of the CCP is to enable and ensure safe human spaceflight and processes for the next generation of earth orbital space systems. The architecture of the Program delineates the process for investment performance in safe orbital systems, Crew Transportation System (CTS) certification, and CTS Flight Readiness. A series of six technical documents build up the architecture to address the top-level CTS requirements and standards. They include Design Reference Missions, with the near-term focus on ISS crew services, Certification and Service Requirements, Technical Management Processes, and Technical and Operations Standards Evaluation Processes.

NASA's interest is not in a fiscal return on investment, but rather in safe crew transportation capabilities and technologies, as measured by the likelihood of an eventual CTS certification. Thus, as a significant investor, NASA requires a partnership which involves enabling, monitoring, and understanding the Commercial Partner's processes, decisions, trades, and risk evaluations affecting the CTS design, production, and operation. The end-to-end CTSs are expected to be owned, managed, and operated by the Commercial Partner. The CCP will manage the national investment by maintaining insight into areas that could affect Investment Performance and future CTS certification.

A Government insight/oversight model can impact the Commercial Partner's cost; therefore, CCP architecture will not use the traditional human spaceflight day-to-day in-depth model. Rather, CCP oversight is focused only on base-lining CTS safety requirements and standards, approving Commercial Partner certification plans, and approving the completion of milestones. CCP insight is modeled as a cooperative partnership to provide NASA the ability to gain a working-level understanding of the Commercial Partner's designs, trades, safety risks, processes, and implementation while assisting the Commercial Partner with technical expertise and issue resolution. The CCP has established CCP Partner Integration Teams to bring working-level understanding and value through strong technical relationships with Commercial Partner counterparts.

Managing risk is the foundation of any architecture. To that end, the CCP empowers the Commercial Partner to define, own, and manage their risk management process. This process will enable the Commercial Partner to identify, mitigate or resolve, and communicate risks throughout all phases of the life-cycle of the project. NASA will have insight into the Commercial Partner's risk management process and resultant data. Significant risks will be elevated within the CCP by the Partner Integration Team, paying particular attention to those risks that pose a threat to CTS certification and safety performance. The CCP will also own and manage a NASA risk management process to control Program investment, certification, safety, and milestone risks. The CCP and the Commercial Partner will jointly understand and manage the risks associated with crew safety and mission success.

NASA CCP's architecture is built on a foundation of safety risk management through the use of focused insight and oversight processes enabling safe human spaceflight and processes for the next generation of orbital space systems, including access to the ISS.



Human Spaceflight Safety for the Next Generation of Orbital Space Systems

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Commercial Crew Program

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Commercial Crew Program Approach



❖ The Program objective is to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from low Earth orbit (LEO) and the International Space Station (ISS).

- Develop and implement a strategy that stimulates U.S. space transportation industry and encourages the availability of space transportation services to NASA and others
- Mature the design, development, demonstration, and certification of U.S. Crew Transportation Systems (CTS) capabilities
- Utilize an alternate business approach by investing in U.S. aerospace industry CTS design and development

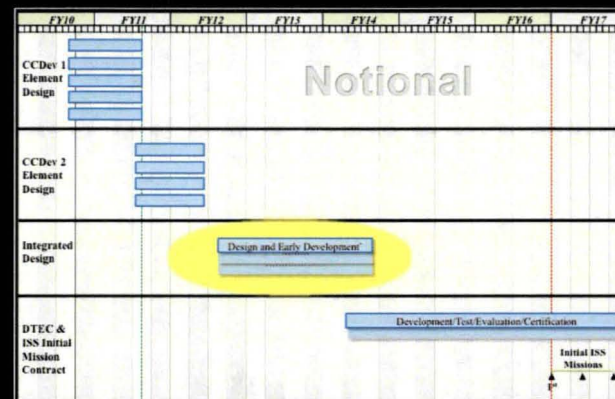


Commercial Crew Program

Commercial Crew Program Strategy Process



Gather Feedback



Assess and Adjust

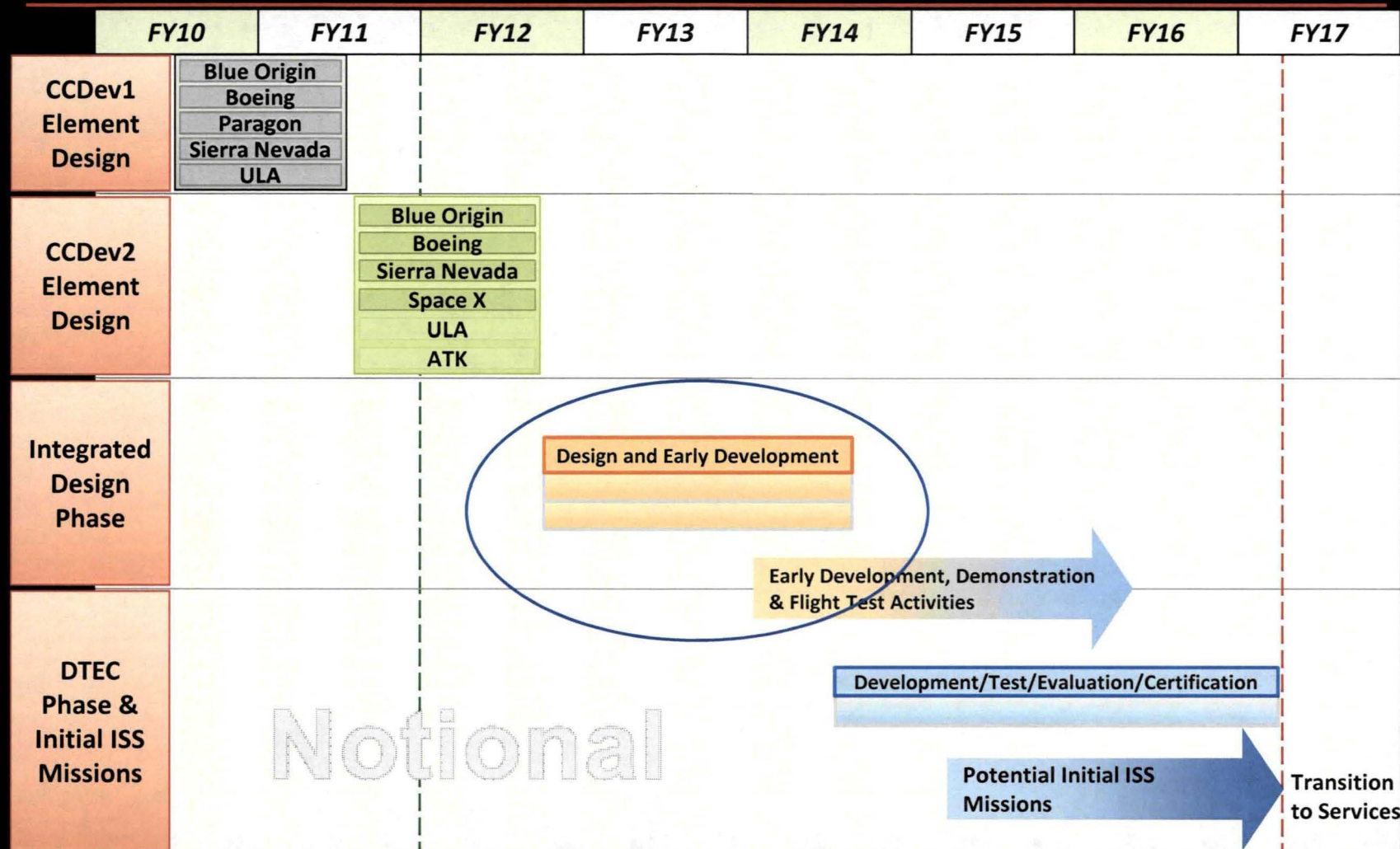


Implement



Commercial Crew Program

CCP Acquisition Roadmap



Commercial Crew Program

CCP Tactical Path for 2012

Commercial Crew Development



Blue Origin



Boeing



Sierra Nevada



Space X

Blue Origin

Pusher Escape Design and
Space Vehicle System
Requirements Review

Boeing

Vehicle Preliminary Design
Review (PDR) and Software
PDR

Sierra Nevada

Early PDR and ETA Free
Flight Test

Space X

Launch Abort Design and
Vehicle PDR

ULA

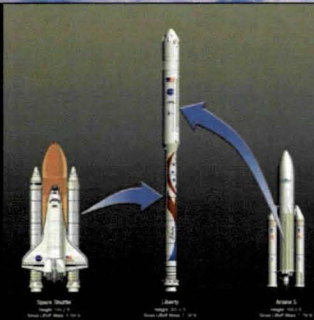
Design Equivalency and
Systems Requirement Review

ATK/EADS

Initial Systems Design and
Program Design Review



United Launch
Alliance



ATK/EADS



Commercial Crew Program

Implementation Approach



Commercial Crew Program

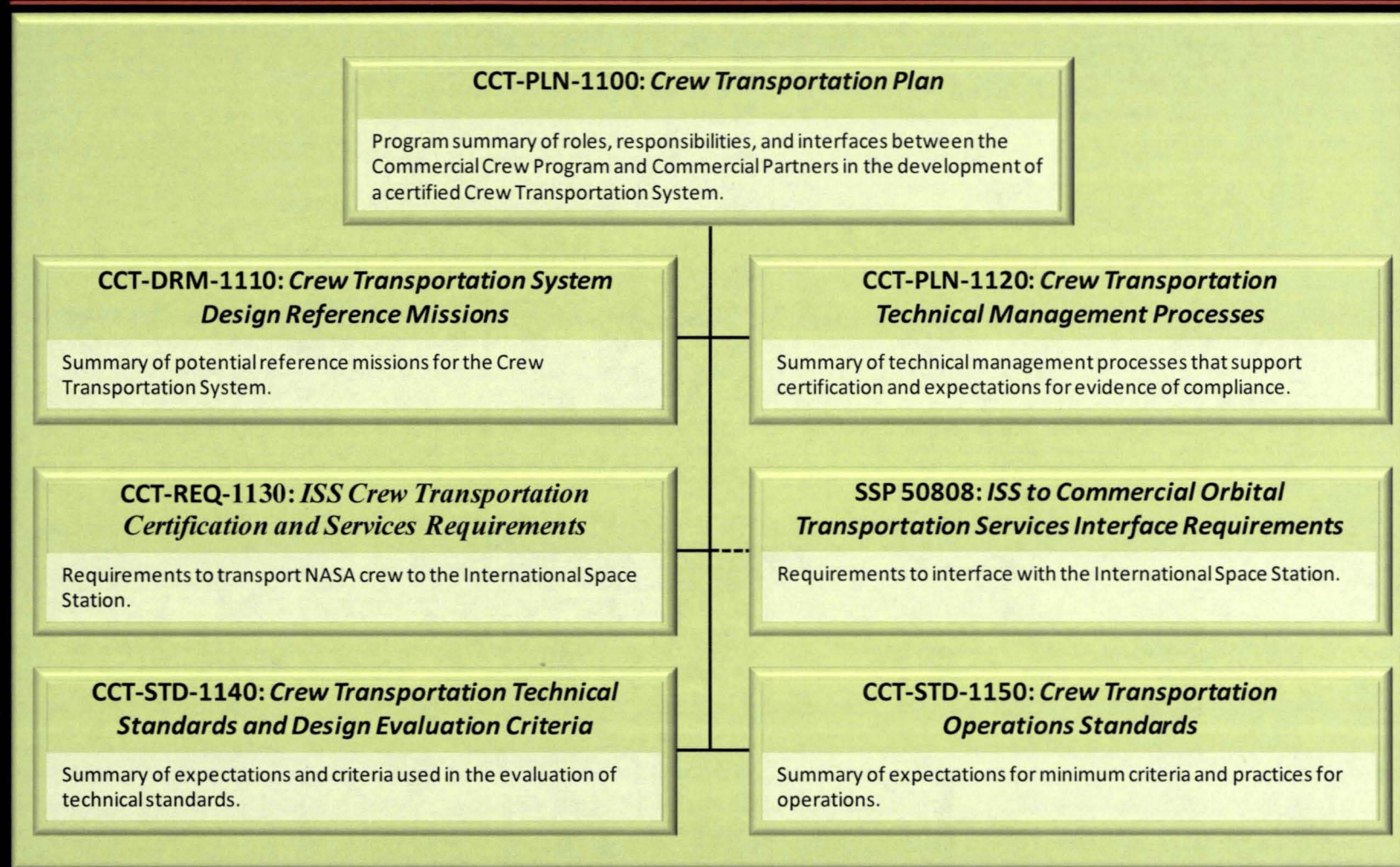
Implementation Approach

❖ Key Technical Areas:

- Processes and Technical Requirements
- Insight/Oversight Methodology
- Certification Process
- Risk Management



Implementation Approach



Implementation Approach

CCT-PLN-1100: *Crew Transportation Plan*

Program summary of roles, responsibilities, and interfaces between the Commercial Crew Program and Commercial Partners in the development of a certified Crew Transportation System.

CCT-DRM-1110: *Crew Transportation System Design Reference Missions*

Summary of potential reference missions for the Crew Transportation System.

CCT-PLN-1120: *Crew Transportation Technical Management Processes*

Summary of technical management processes that support certification and expectations for evidence of compliance.

- ❖ Conveys NASA's intent to facilitate the development of a U.S. commercial crew transportation capability to and from the ISS.
- ❖ Describes the relationship between NASA and Commercial Partners in the areas of:
 - Insight/Oversight
 - Certification
 - Supporting Processes

Implementation Approach

CCT-REQ-1130: ISS Crew Transportation Certification and Services Requirements

Requirements to transport NASA crew to the International Space Station.

SSP 50808: ISS to Commercial Orbital Transportation Services Interface Requirements

Requirements to interface with the International Space Station.

- ❖ CCT-REQ-1130 contains ISS destination and transportation services requirements.
- ❖ SSP 50808 contains the interface requirements that apply during ISS integrated operations.
- ❖ These two documents provide the technical requirements for a NASA certification toward crew transportation services to the ISS.



Commercial Crew Program

Implementation Approach

CCT-STD-1140: *Crew Transportation Technical Standards and Design Evaluation Criteria*

Summary of expectations and criteria used in the evaluation of technical standards.

CCT-STD-1150: *Crew Transportation Operations Standards*

Summary of expectations for minimum criteria and practices for operations.

- ❖ Provides guidance and expectations for standards and practices.
 - Allows for tailoring with “meets intent” applicability.
- ❖ Describes engineering work products and practices that demonstrate nominal technical rigor, both in design and operation.



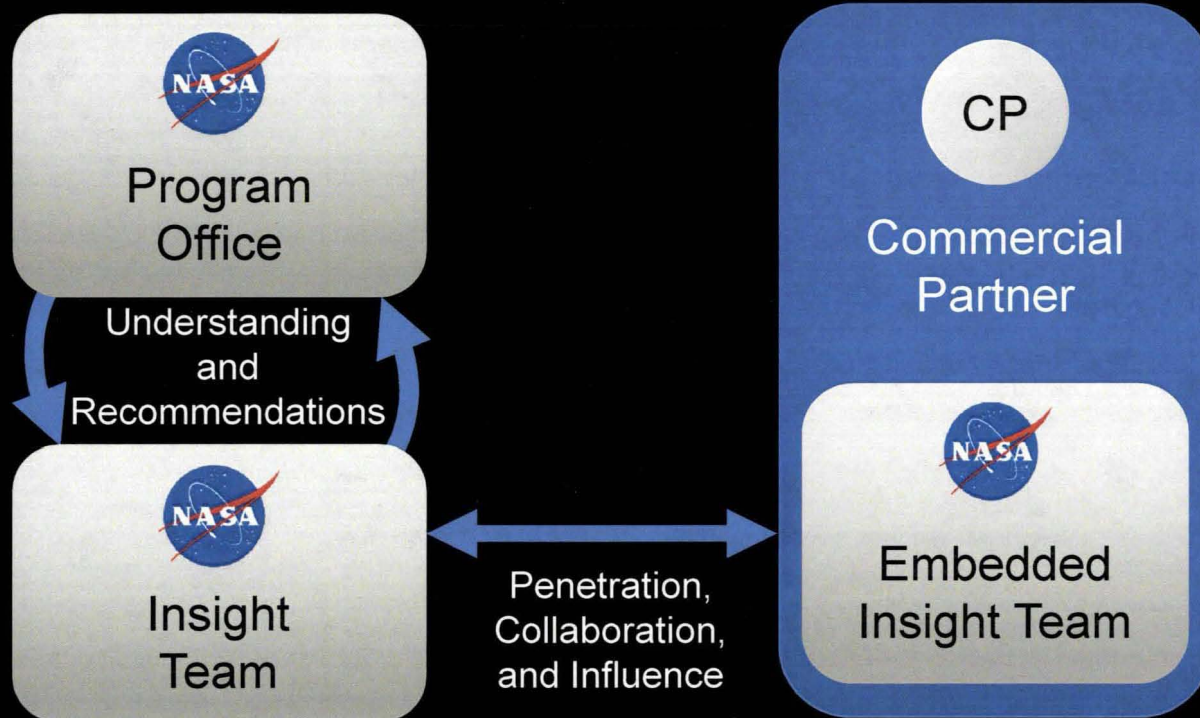
Insight/Oversight Methodology



Commercial Crew Program

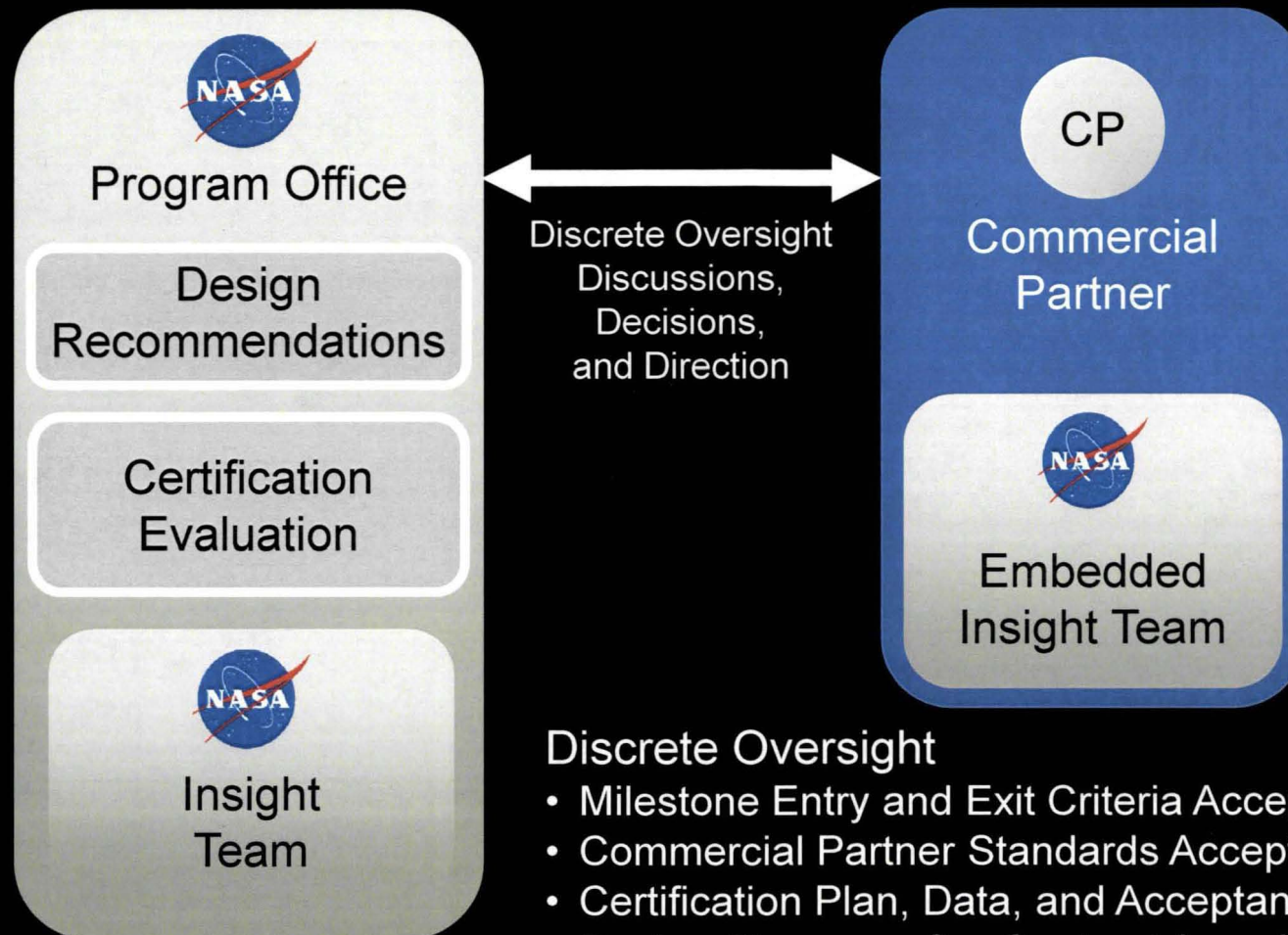
Path For Insight

*Insight Role:
Knowledge Sharing, Early Issue Identification, and Recommendations*



The purpose of the Embedded Insight Teams is to develop a long-term, trusting relationship with the Commercial Partner, yielding significantly greater insight.

Day-to-Day Communications Path for Oversight



Discrete Oversight

- Milestone Entry and Exit Criteria Acceptance
- Commercial Partner Standards Acceptance
- Certification Plan, Data, and Acceptance
- Design Changes after Contract Award
- Certificate of Flight Readiness



Insight/Oversight Methodology

❖ Insight:

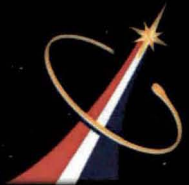
- CCP's emphasis for insight is to gain a detailed working-level understanding of the Commercial Partner's approach and implementation of design, requirement flow-down, trades, risks, and processes leading to CTS certification with minimum effect to the Partner's rhythm.
- Insight Teams will have access into the Commercial Partner's change process and will, with the appropriate Program oversight, assess any changes impacting the implementation of Program requirements and provide structured feedback.



Insight/Oversight Methodology

❖ Oversight:

- Oversight's primary role is the technical understanding leading to CTS certification.
 - Provide a uniform understanding and management of certification requirements and standards for all Commercial Partners
 - Identify major problems (affecting certification) and provide resolution recommendations to Program management
- CCP will maintain a two board structure, Program and technical.
 - Minimize overhead and provide an efficient review/feedback process



ISS Program Integration

❖ CCP acts as ISS liaison for Joint Products.

❖ ISS Program:

- Defines ISS to spacecraft interface, ISS rendezvous, proximity operations, and docked operations requirements.
- Reviews and approves verification closure of associated requirements.
- Supports CCP in closure of ISS requirements and planning for any joint ISS mission operations activities.
- Participates with the Insight Teams as necessary to assist in issue resolution related to interfaces or operations to the ISS.



Certification

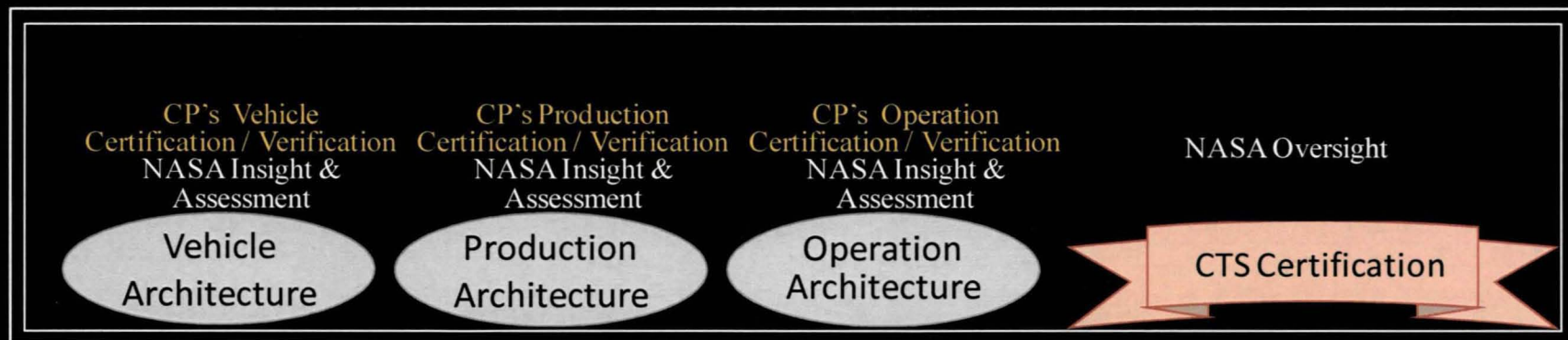


Commercial Crew Program

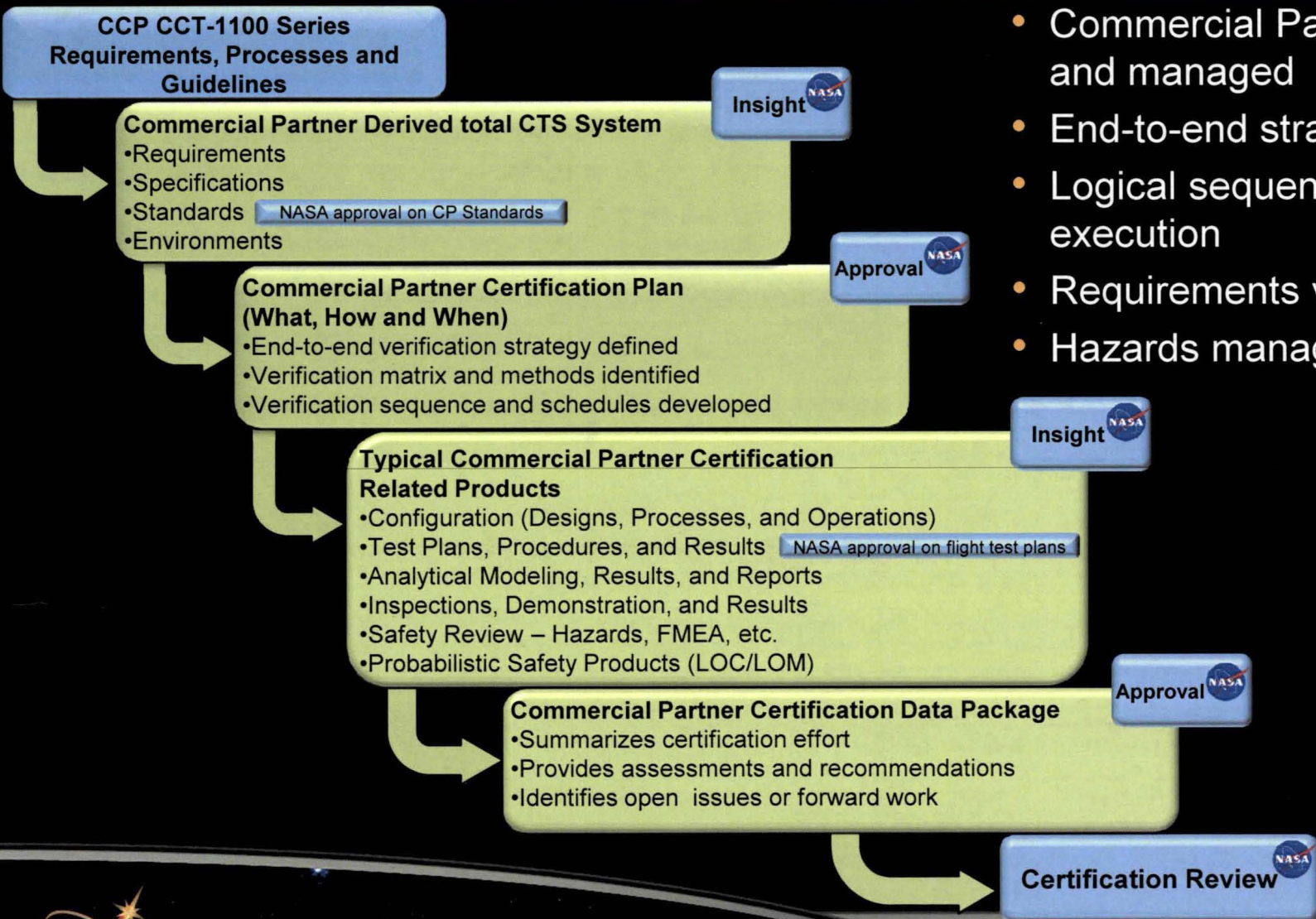
CTS Certification

❖ CTS certification is based on:

- Objective evidence that the Commercial Partner has achieved the design, performance, operations, and safety requirements as defined by or derived from NASA CCP requirements.
- The use of trusted verification and validation methods (test, analysis, demonstration, and inspection).
- A thorough understanding of systems hazards and management of the associated risk, which includes an effective means for implementing and maintaining effective hazard controls.



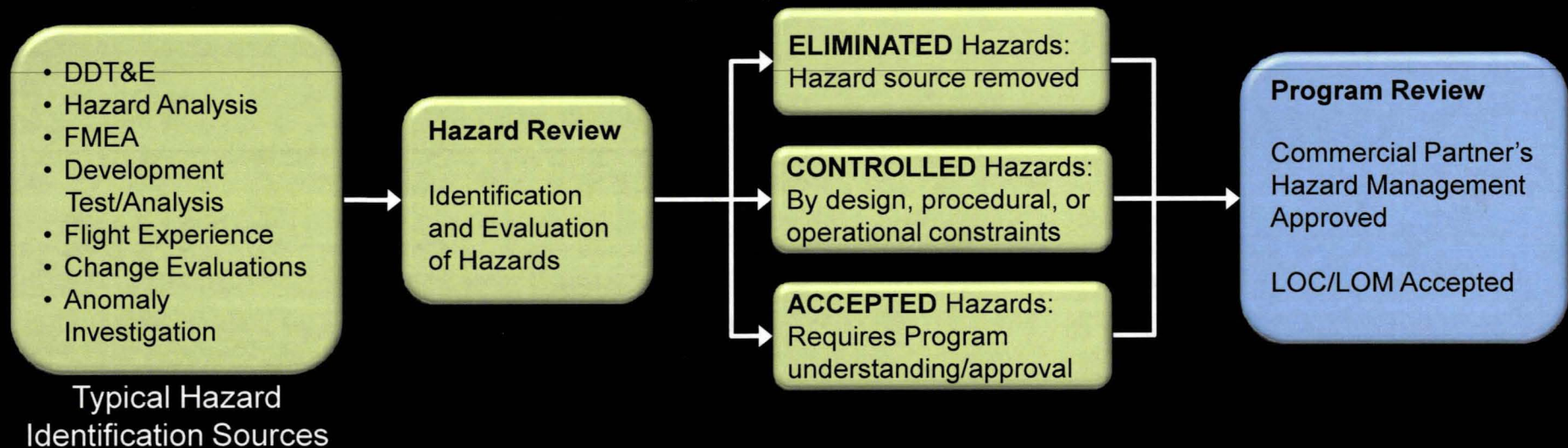
CTS Certification



- Commercial Partner led and managed
- End-to-end strategy
- Logical sequential execution
- Requirements verified
- Hazards managed

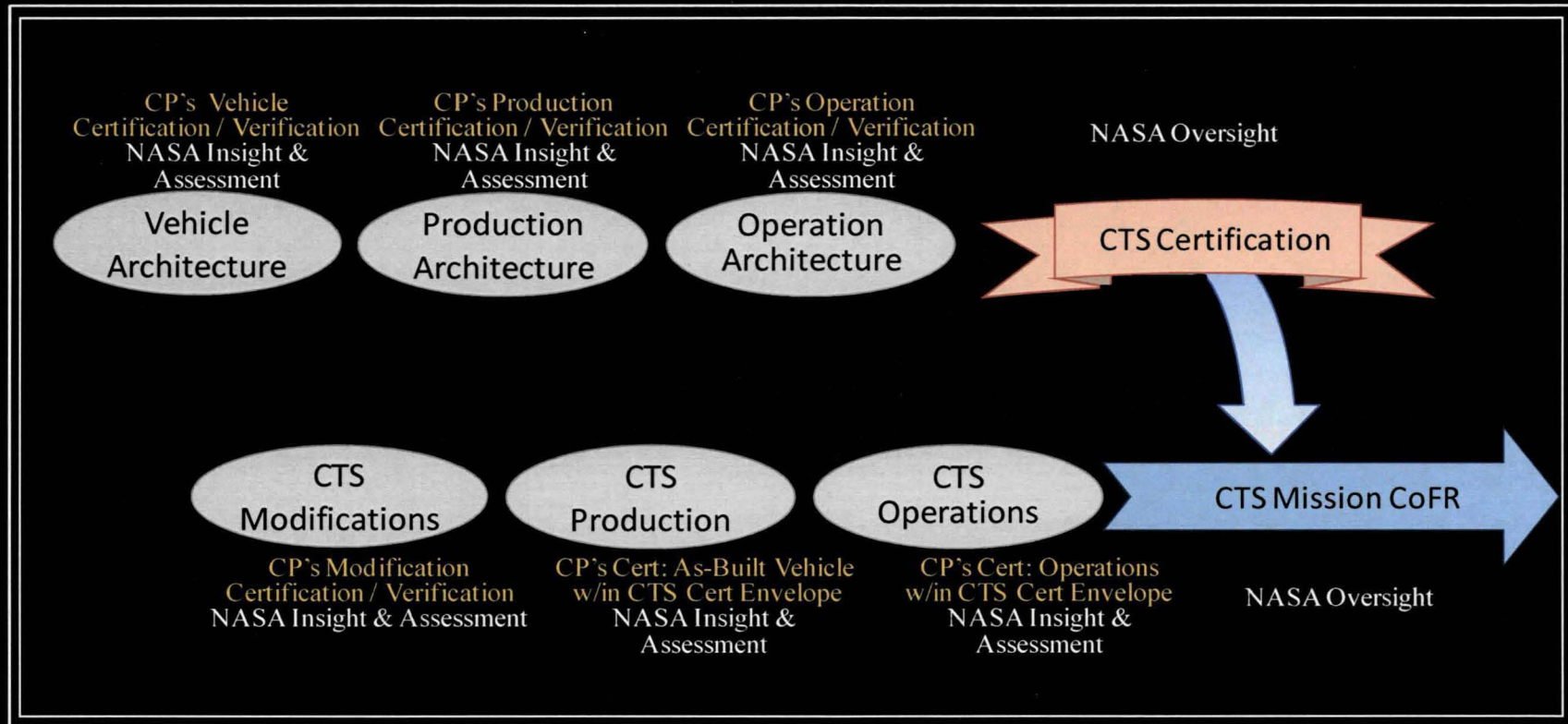
CTS Certification

- ❖ To achieve certification, the CTS design must be capable of reliable, predictable, and consistent performance. This requires the effective management of hazards.
 - Hazards must be identified and understood.
 - Hazards must be effectively managed (Eliminated, Controlled, or Accepted).
 - Hazards must be continuously re-evaluated as changes occur.
 - Hazard controls must be effectively implemented and maintained.



CTS Certification

- ❖ Successful CTS certification represents the Commercial Partner's completion of the first major step towards CTS flight and mission readiness.



Risk Management

- ❖ The Commercial Partner leads and manages cost, technical, and schedule risk of designs.
 - Commercial Partner identifies, mitigates, and resolves risks
 - Risks related to certification and hazards elevated to NASA concurrence
- ❖ NASA Risk Management focuses on investment, certification, and safety hazards.
- ❖ NASA is accountable for crew safety risks.

NASA Risk Management System

- Identify
- Evaluate
- Mitigation Plans
- Communicate and Manage Risks with Commercial Partner
- Communicate Risks to Agency

NASA Insight Level Risk Assessment

- Evaluate significant Commercial Partner Risks
- Evaluate Commercial Partner Mitigation Plans
- Coordinate Safety Risks into the Commercial Partner's Risk Management System

Focus on Significant Commercial Partner Risks

- Certification Performance
- Hazard Control Changes
- Analytical Modeling, Results, and Reports
- Safety Review – Hazards, FMEA, etc.
- Probabilistic Safety Products (LOC/LOM)

Commercial Partner Risk Management System

- Identify
- Evaluate
- Commercial Partner Mitigation Plans
- Communicate Risks to Commercial Partner Team

Insight

Insight



Commercial Crew Program

Safe Spaceflight Architectural Foundation

*NASA Approach to
Safe Human Spaceflight to ISS*



NASA Acceptance of Flight Readiness



NASA Approval of Design Certification



NASA Commercial Partner Insight Process



Safety Risk Management Foundation

Our ISS is Waiting...



Commercial Crew Program

